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FORMATION SPECIFICS OF HEAT-ABSORBING FLOAT GLASS

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A qualitative assessment of the spectral and viscosity-temperature parameters of heat-absorbing glass in comparison with standard clear glass is performed, and its molding specifics are clarified. Based on the patent literature and the practical experience of glass production on the ÉPKS-4000 line at the Saratov Institute of Glass, the need for modifying the structural elements of the overflow unit and the molding conditions, in order to produce high-quality heat-absorbing materials, is demonstrated.

The demand for heat-absorbing glass keeps steadily growing in Russia and abroad, due to the wide areas of application of this glass in glazing for various types of buildings, in transport vehicles, and in various glass structures. Such glass selectively absorbs infrared radiation and thus facilitates creating a more comfortable and healthy environment in interiors and allows for significant savings in air-conditioning expenditures. Tinted and decorative heat-absorbing glass expands the resources of architects and designers in solving both functional and artistic problems related to the application of glass and glass products.

The variety of spectral parameters and color shades of heat-absorbing glass is provided by special additives introduced to the glass composition [1]. The additives modify not only the properties of the finished glass, but also the parameters of the technological process, in particular, molding. Such parameters include viscosity-temperature characteristics, IR spectrum absorption, and other properties.

It is known that the process of float glass formation consists in two phases: spreading of the glass melt in the glass overflow unit and lateral-longitudinal stretching of the glass band in the active molding zone [2, 3].

The spreading phase usually ends when the glass melt becomes plane-parallel. Without obtaining a plane-parallel layer, it is impossible to ensure a high quality of the molded band. Uniform spreading occurs under the effect of the gravitation and surface tension forces, provided that the glass melt viscosity does not exceed 10^3 Pa · sec and that the spreading duration is sufficient for the formation of a plane-parallel layer. The lateral-longitudinal stretching ends when a glass band of the required width and thickness is formed.

Other significant factors in molding are the geometry and the arrangement of the structural elements in the overflow unit, which are strictly determined and provide for the specific migration scheme of the glass melt flows (Gr. Britain Patent Nos. 1025581 and 1129079).

A very important requirement consists in the constant renewal of the glass melt in the flow. The length of the flow and the speed of movement should be selected in a way to prevent the formation of stagnant sites in which the glass starts crystallizing and gives origin to defects.

Let us consider in more detail the properties of heat-absorbing glass, namely, the spectral and viscosity-temperature characteristics with respect to the molding process.

At the temperatures of the float process, heat transfer is mainly carried out via radiation; therefore, the IR spectrum absorption parameters have a certain effect on the heat exchange between the glass band and the ambient medium and between different glass layers inside the glass band [4].

Under the conditions of thermal equilibrium, an increase in the IR absorption is accompanied by increased radiation in the same spectral range [5], in other words, heat-absorbing glass has to release heat faster. This is especially obvious in the case of a glass layer of substantial thickness, which can be observed in the overflow and spreading unit. The arising difference between the temperatures in the middle and the surface layers, and the increasing viscosity of the surface layers, develop the effect of quick "solidification" of glass, although the middle layers retain their fluidity [6]. Therefore, glass with a high absorption coefficient behaves as "shorter" glass.

As for the viscosity temperature interval, the estimated and experimental data obtained by the glass-melting department of the Saratov Institute of Glass indicate that this interval is narrower in heat-absorbing glass than in clear glass (in the overflow and spreading unit it is 30 – 40°C lower and in the active molding zone it is 10 – 20°C lower).

Furthermore, the absorption coefficient affects the roof heating efficiency. Whereas in melting clear glass, which is sufficiently transparent in the IR spectral range, one can talk

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of uniform heating of the glass melt across its width, in the case of heat-absorbing glass, the greater part of the radiation from the heaters is absorbed on the upper surface and inside the glass bulk. Therefore, an additional temperature gradient and, accordingly, a viscosity gradient arise across the glass thickness. This causes the peeling defect and deteriorates the glass quality parameters.

All this indicates that special conditions inside the melting tank are needed in the case of producing heat-absorbing glass, which is especially true of the phase of glass melt overflow and spreading, since the modifications of the viscosity-temperature properties are the most evident at this phase.

The first float glass lines were designed for making clear glass; therefore, the conditions of spreading of the glass melt in the front part of the melting tank and the active molding conditions correlated with clear glass technology.

As the Saratov Institute of Glass developed the technology for heat-absorbing glass, it was established that the production of high-quality heat-absorbing glass is hampered unless the structural elements of the overflow unit and the molding conditions are modified.

Experimental research and the practice of producing heat-absorbing glass on the ÉPKS-4000 line revealed the need to increase the glass melt temperature in the working channel and the advisability of shortening the flow length in the overflow unit. An analysis of the patent literature corroborated the validity of this solution (U.S. Patent No. 3743495). At present, the flow length on the Saratov Institute production line is significantly shorter than on other domestic and foreign lines for clear glass production.

The production of heat-absorbing glass also calls for modification of the active molding conditions, namely, the position of the edge-retaining machines and the adjustment of the roof heating level.

Compared with clear glass, heat-absorbing glass requires a shorter active molding zone. However, excessive shortening is inadmissible, since it can lead to the impossibility of controlling the glass thickness uniformity using the edge-keeping machines.

Molding conditions are individually chosen for each composition of heat-absorbing glass and for each float tank.

The Saratov Institute of Glass currently possesses technologies for production of tinted heat-absorbing glass of various color shades: greenish – light blue, gray, bronze, pink. In addition to flat sheet glass, the Institute has developed decorative glass varieties ("Snowstorm" and "Rhythm") based on heat-absorbing glass.

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